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OCEANOGRAPHIC STUDY CANUS-SLAMEX, 15-25 MAY 1963.(U)
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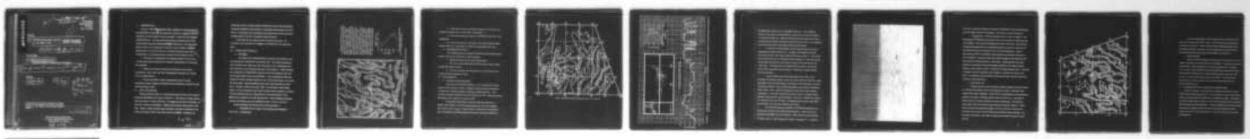

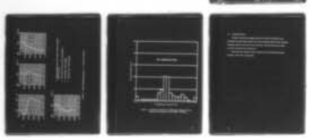

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I. INTRODUCTION

The U.S. Naval Oceanographic Office assigned two oceanographers to the USS ESSEX to conduct an environmental prediction program was conducted in support of operation CANUS-SLAMEX-63 and Commander, Carrier Division Eighteen (COMCARDIV 18). The value of the experimental Antisubmarine Warfare Environmental Prediction System, ~~(ASWEPS)~~ especially in providing oceanographic charts for locating areas of optimum sonar conditions, ~~has been~~ was demonstrated on many ASW exercises conducted during the past 4 years. Oceanographic forecasting objectives during CANUS-SLAMEX-63 were:

1. Evaluation of oceanographic forecasting methods for the purpose of improving existing methods and to ascertain requirements for developing new techniques.

2. Preparation of detailed analyses and forecasts of sea surface temperature, layer depth, and other oceanographic parameters for presentation to COMCARDIV 18.

3. Tactical evaluation of these oceanographic factors through conversion to sonar ranges and subsequent recommendations of optimum sonar areas and convoy routes.

II. DATA COLLECTION

During CANUS-SLAMEX-63, 188 bathythermographs (BT's) were received aboard the USS ESSEX from units of CARDIV 18. The majority of these observations were made to a depth of ? 800 feet. By staggering the daily BT schedules, an even flow of data was maintained. Weather did not hamper observation at anytime. Indeed, adverse weather (fog) prompted an increase in frequency of sea surface temperature (SST) observations aboard the ESSEX, resulting in an

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observation every 15 minutes between 20/2000 and 25/0215 May (local time). During the remainder of the exercise, temperature observations were made hourly. The quality of BT and injection temperature observations was good, although several of the BT's appeared to need calibration.

A helicopter BT was utilized by HS-9 during this exercise. BT collectives were sent daily via message to NAVOCEANO by the prediction team.

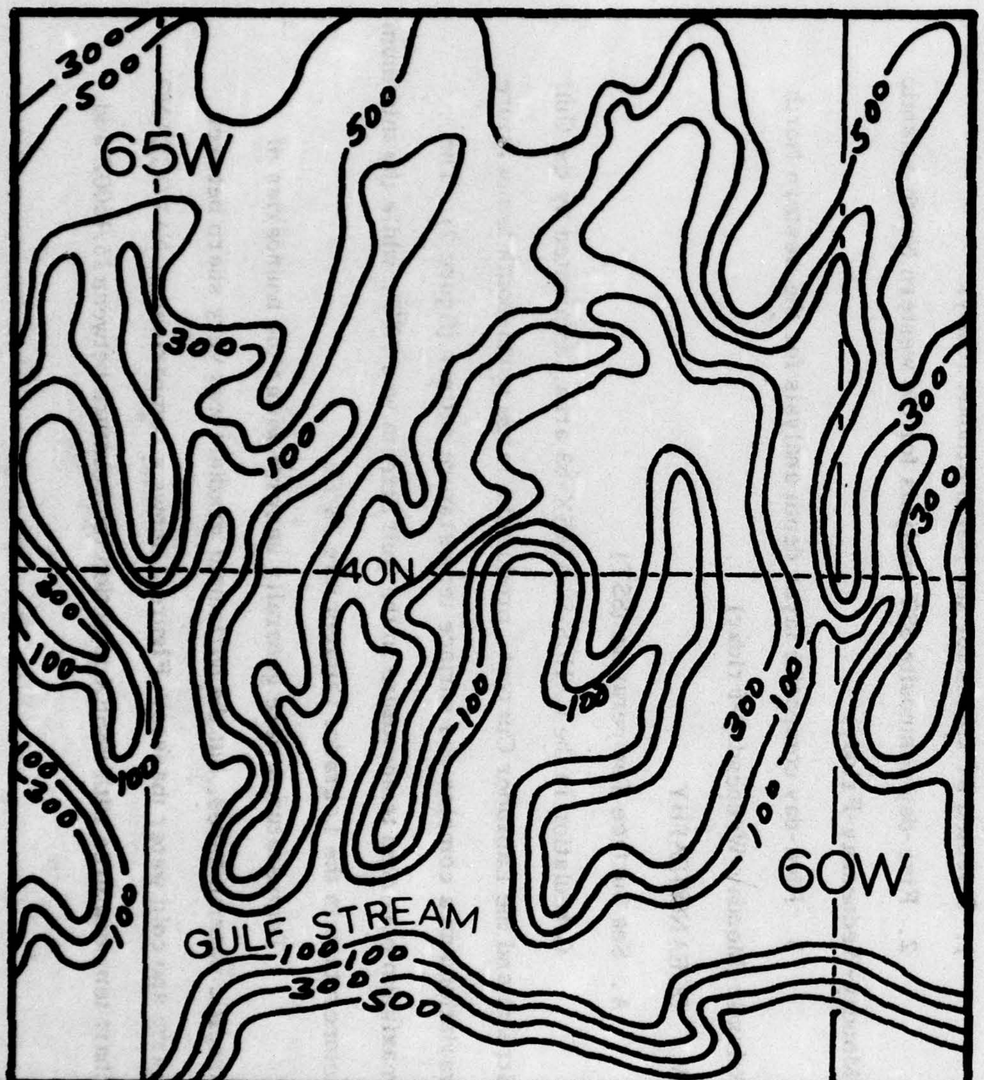
III. FORECASTING PROGRAM

A. USS ESSEX

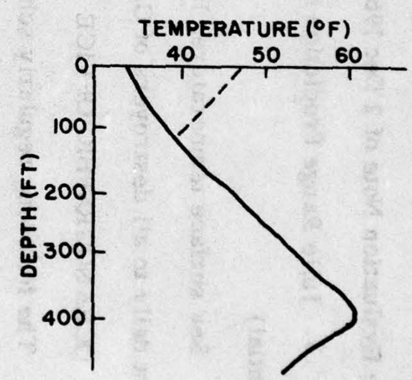
An outlook of the expected thermal structure in the operation area was forwarded to COMCARDIV 18 on 10 May 1963. The outlook included the latest available layer depth chart and a discussion of the modifications that were expected to occur during the last part of May (figure 1). Daily briefings were conducted for COMCARDIV 18 and his staff by the prediction team and by the meteorologist aboard the USS ESSEX. These briefings included presentation of 24-hour predicted patterns of sea surface temperature, layer depth, and sonar range. Recommendations were made concerning optimum sonar areas, optimum variable depth sonar (VDS), and helicopter sonar dipping depths, as well as possible areas of good visibility when fog became a problem. The daily briefings were also attended by the commanding officer of the ESSEX and an observer from the Canadian Navy. Daily briefings concerning the same parameters were also conducted for HS-9, VS-29, and VS-32.

Range predictions were based on the following systems:

1. NAVSHIPS 900,196, Manual for Estimating Echo Range(U), March 1959. (Confidential)



The layer depth pattern indicated on 10 May can be expected to prevail until about 20 May. The pattern is typical of winter; however, since May is a transition month, partial summer conditions are expected by 30 May. The cool water south of the Gulf Stream will become shallow during the last week in May and will have a gradient of approximately $2^{o}F$ for the first 100 feet. The cold water above $40^{o}N$ has positive temperature gradient to 400 feet; however, the surface will continue to heat during May and produce a negative gradient above the positive gradient. This is a sound channel, the center of which will be located at a depth of approximately 100 feet.



Warm water areas (Gulf Stream) will not change significantly.

Figure 1 Initial Forecast Composite Layer Depth (Ft) Chart
6 - 10 May 1963

2. Underwater Ray Path and Range Prediction (U), KWESTEVDET (Advance Evaluation Note of 2 Dec 1960). (Confidential)

3. Julie Range Prediction Manual (U), NAVWEPS 00-80T-83A, 1962. (Confidential)

Sea surface temperature, layer depth, and range prediction charts were sent daily to all destroyers of CARDIV 18 via helicopter mail runs.

B. OCEANOGRAPHIC OFFICE

The following regularly scheduled NAVOCEANO experimental oceanographic charts were transmitted via NSS Washington.

1. Selected BT traces for the North Atlantic (daily)

2. Five-day composite SST analysis for the western North Atlantic (Monday-Wednesday-Friday)

3. Five-day composite layer depth analysis for the western North Atlantic (Monday-Wednesday-Friday).

IV. OCEANOGRAPHY

A. Sea Surface Temperature (SST)

Circulation in the CANUS-SLAMEX-63 area, dominated by the Gulf Stream and the Labrador Current, produced a large north-south temperature variation and a complex sea surface temperature pattern (figure 2). The maximum observed temperature in the Gulf Stream was 78°F, while the minimum temperature in the Labrador Current was 38°F.

Temperatures were generally uniform within the boundaries of specific water masses, but the horizontal gradient was very sharp between warm and cold water masses. Figure 3 shows a comparison of NAVOCEANO chart temperatures with ESSEX injection temperature between 15/1600Z and

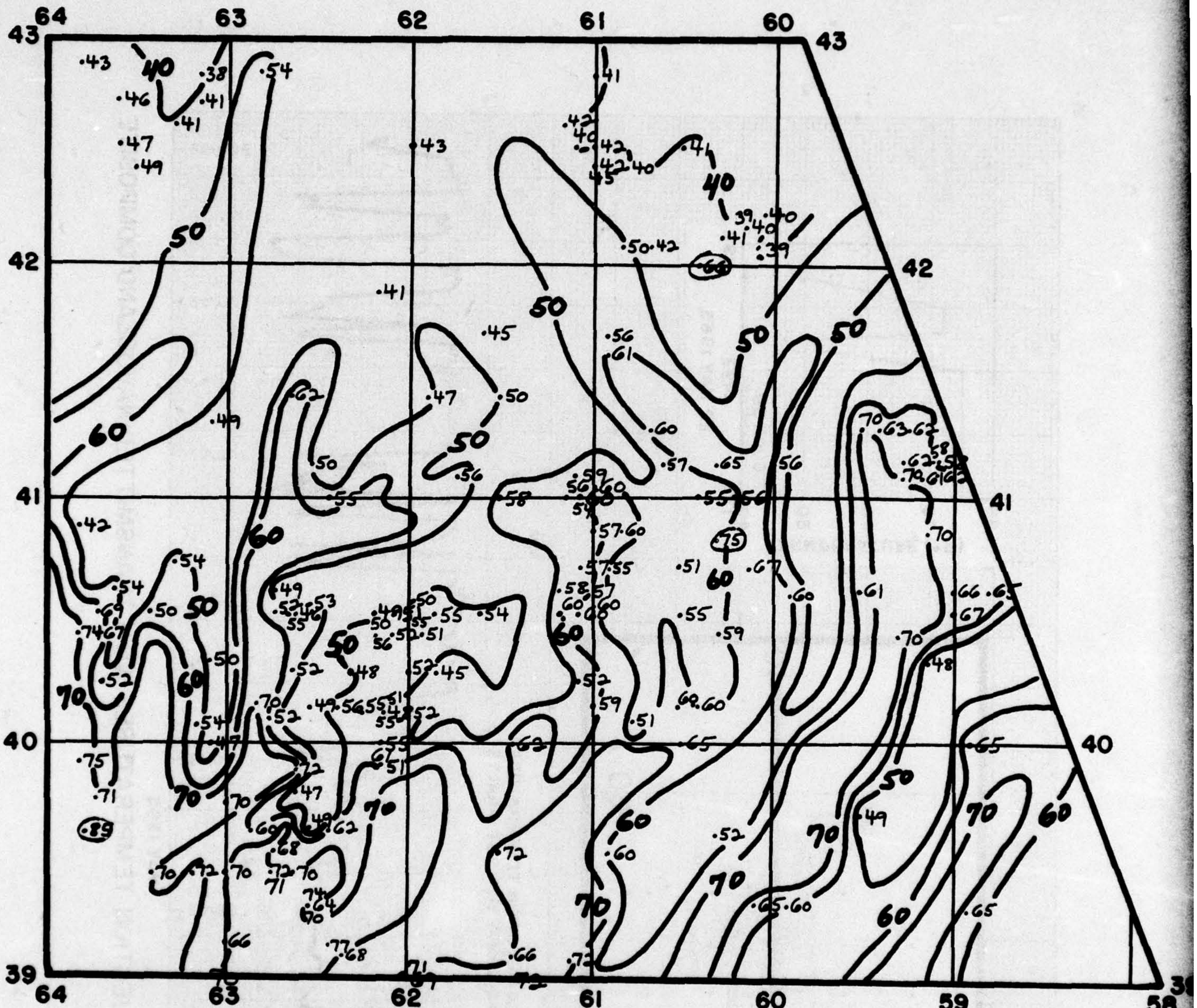


Figure 2 Composite Sea Surface Temperature Chart 17 - 23 May 1963

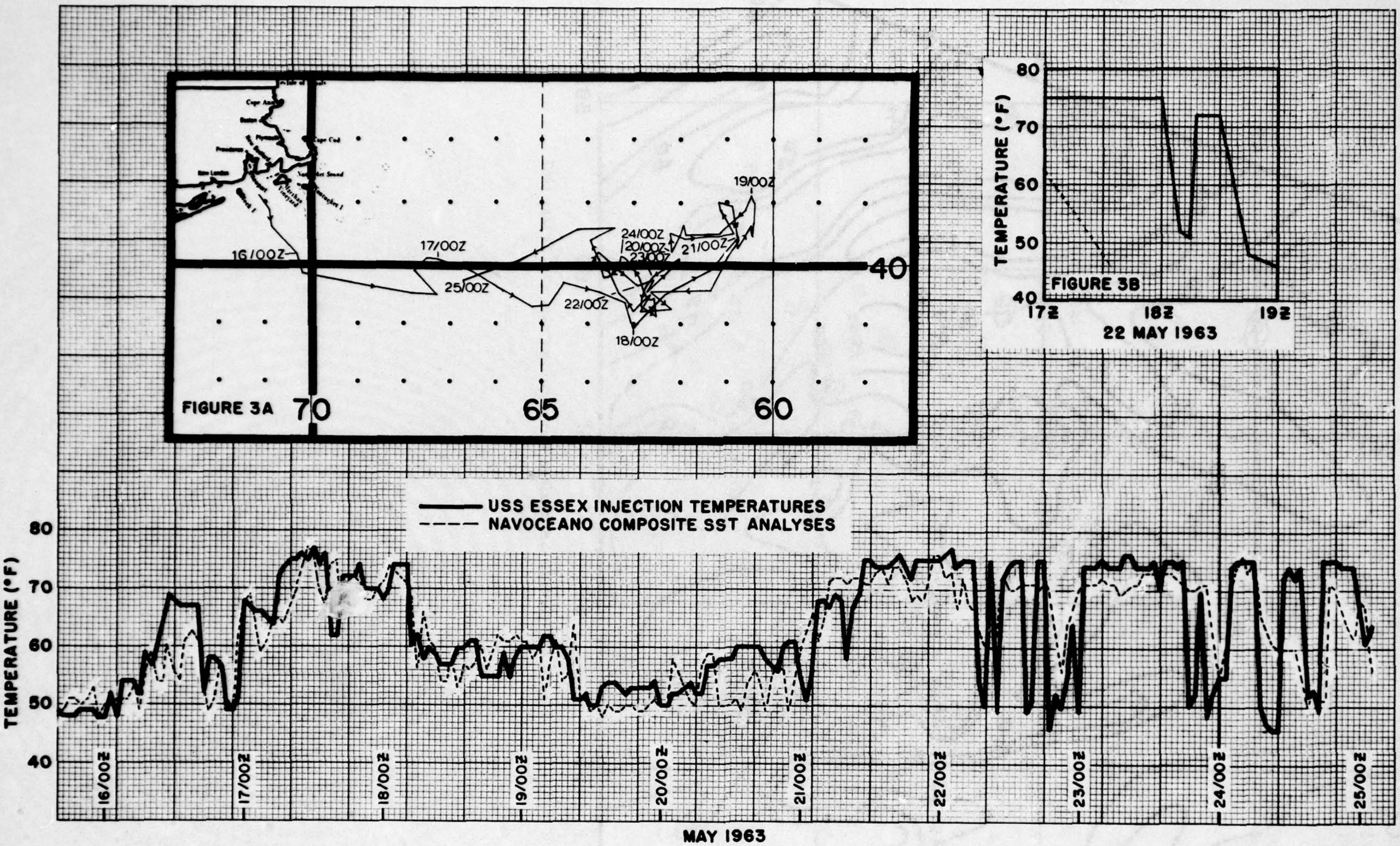


FIGURE 3 COMPARISON OF USS ESSEX INJECTION TEMPERATURES WITH TRANSMITTED NAVOCEANO COMPOSITE SST CHARTS 15–25 MAY 1963.

25/0200Z May along the track of the ESSEX (figure 3a). The outstanding feature of this record is high variability in temperature over short distances as evidenced by figure 3b. Sharp horizontal temperature gradients are known to exist along the northern boundary of the Gulf Stream; however, the magnitude and width of the gradient zones seldom have been determined.

On 22 May one such gradient zone was noted through temperature difference and change in water color. A distinct line between gray-green, cold water and blue, warm water masses can be seen in figure 4. The contrast is even sharper in color reproductions of this photograph.* Distances between the maximum and minimum values shown in figure 3b were estimated to be 1,000 yards. This graph does not indicate absolute distance, because the ship's course and speed were not constant. Visibility was slightly reduced over the cold water.

The sea surface temperature distribution and its effect on fog formation or dissipation played a major role during CANUS-SLAMEX-63. High frequency of fog in May threatened air operations in the northwestern portion of the Atlantic; however, areas of good flying weather were located by utilization of SST charts. Warm, moist air passing over cold surface water produces condensation. If the water temperature is nearly equal to or slightly greater than the air temperature, fog will dissipate. On 21 May, visibility was reduced to 1,000 feet by fog over 51°F water. By maneuvering into warm water (68°F), the ship entered an area where visibility was 6 miles.

Composite SST analyses prepared at NAVOCEANO between 10 and 23 May were utilized as the primary forecasting tools. These charts were received by the ESSEX via radio facsimile. Their validity was demonstrated

* On file at the U.S. Naval Photographic Center, Washington, D.C. #KN5148

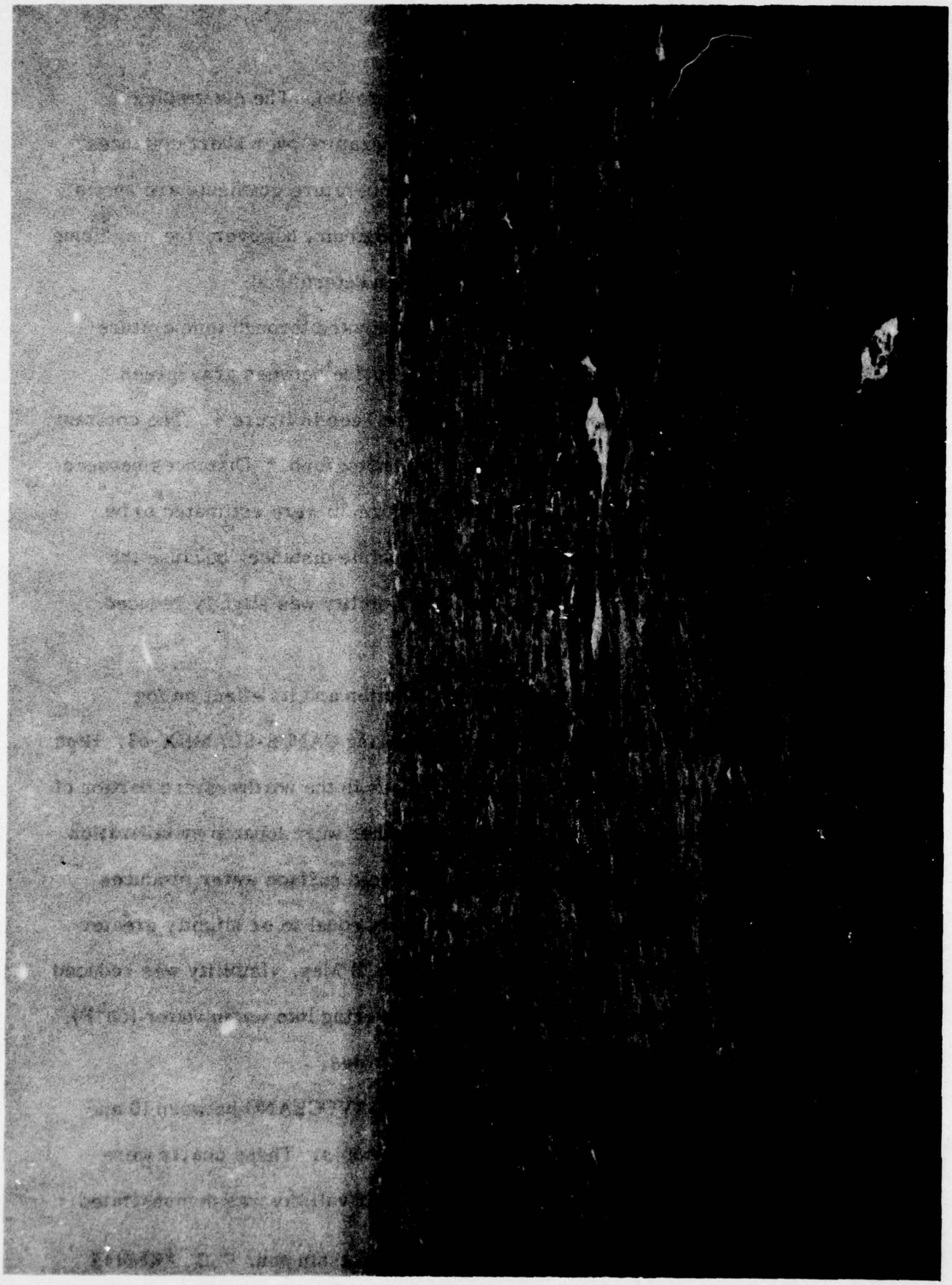


Figure 4 Transition Between Warm (foreground) and Cold Water Masses

by hourly comparisons between interpolated NAVOCEANO surface temperatures and USS ESSEX injection temperatures. The results are shown in figure 3.

Although there is similarity between the two curves in figure 3, the interpolated NAVOCEANO temperatures were not as extreme as those observed by the ESSEX. The similarity between the curves is important, since properly located temperature features permitted the charts to be used in relative terms for forecasting thermal structure as well as for forecasting fog. Errors were greatest (22°F at 22/1500Z) in the transition zone (northern boundary of the Gulf Stream), where horizontal temperature changes of approximately 25°F were observed within distances of 1,000 yards. Large gradients occurring within small distances cannot be thoroughly analyzed on the regional charts, because a dense network of data is required to pinpoint gradient zones. Depiction of extreme horizontal gradients on the regional radiofacsimile charts is difficult, and therefore a high correlation with observed data does not result from a point-for-point verification.

B. Layer Depth (LD)

Vertical thermal structure patterns observed during CANUS-SLAMEX-63, like the SST patterns, were very complicated; however, individual water masses were readily identified. Winter SST-LD relationships prevailed (deepest layers in cold water, relatively shallow layers in warm water, and shallow layers in areas of sharp horizontal temperature gradients). The observed layer depth values and the layer depth analysis are shown in figure 5. Mixed layers in warm water generally ranged from 150 to 200 feet, while those in cold water were greater than 400 feet and occasionally reached 900 feet. For purposes of this study, layer depth is defined as the depth of maximum sound velocity.

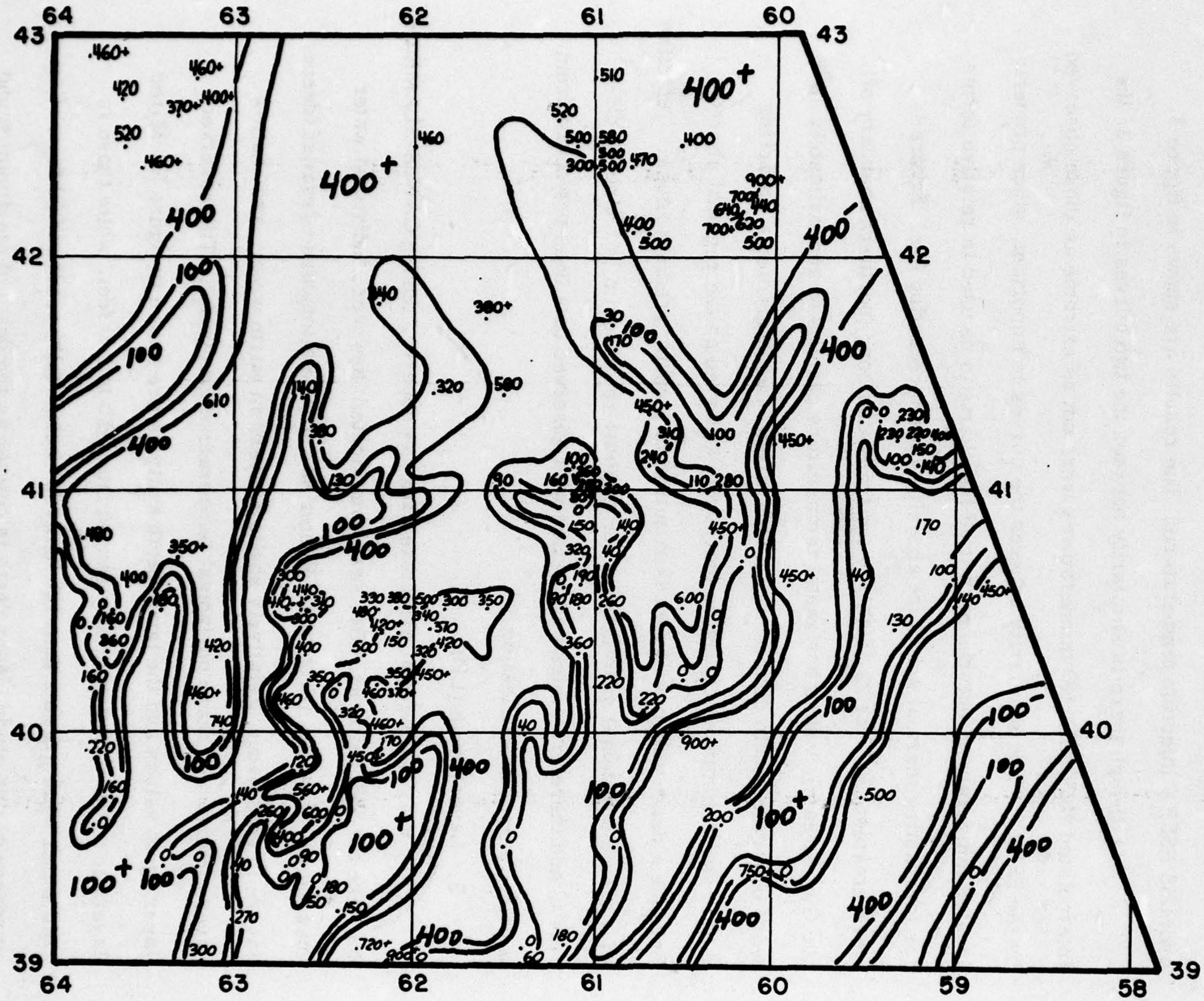


Figure 5 Composite Layer Depth Analysis 17 - 23 May 1963

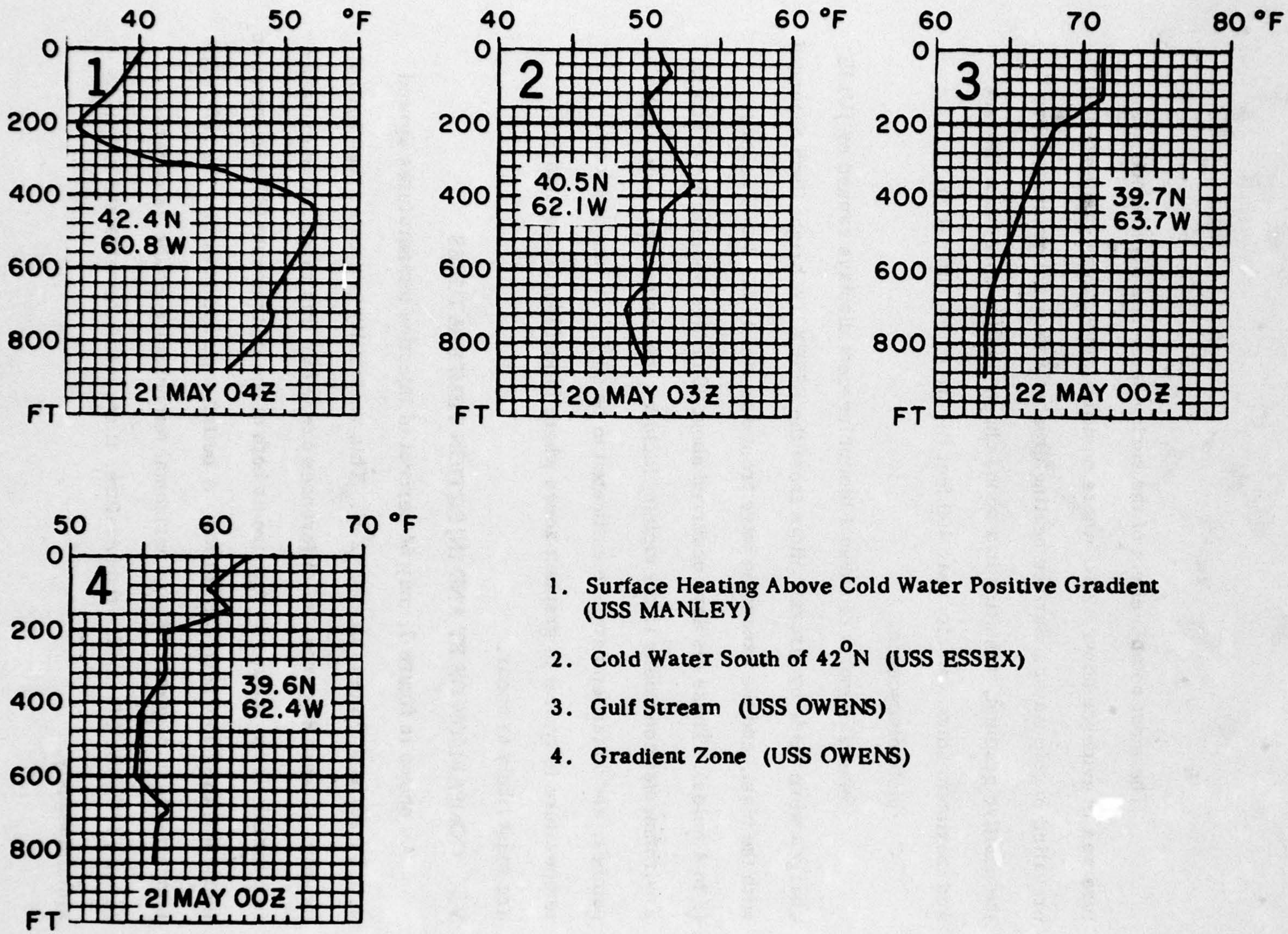
The most notable effect of the spring season on the thermal structure was in evidence above 42^{o}N, where positive temperature gradients had prevailed in cold water. Surface heating created a negative gradient above the positive gradient, resulting in a sound channel with a core near 200 feet and maximum sound velocity near 400 feet (figure 6, BT number 1).

C. Bioluminescence

Several reports of unusual bioluminescent displays caused by JULIE charges were made by aircraft pilots from the ESSEX. A bright flash occurred with the blast, and the expanding wave front was visible for 3 to 5 seconds (3 to 4 miles). These displays occurred about 300 miles south of Nova Scotia. Environmental conditions in the vicinity included low seas, clear sky, fog patches, and water temperature estimated to be 60^{o}F. In this study this temperature is typical of gradient zones where bioluminescent displays are most likely to occur.

V. COMPARISON OF BT AND INJECTION TEMPERATURES

As shown in figure 7, only 64 percent of injection temperatures agreed with BT surface temperature by $\pm 2^{o}$F. This variability is greater than normal; usually, at least 80 percent of differences are within this range. One explanation for this large scatter is that one or both of the instruments (BT and injection thermometers) may need calibration. A better explanation is that the reference temperature in regions of sharp horizontal temperature gradients differs greatly from the BT surface temperature, if the measurements are not taken simultaneously.



1. Surface Heating Above Cold Water Positive Gradient (USS MANLEY)
2. Cold Water South of 42°N (USS ESSEX)
3. Gulf Stream (USS OWENS)
4. Gradient Zone (USS OWENS)

Figure 6 Typical Bathythermograms —— CANUS-SLAMEX-63

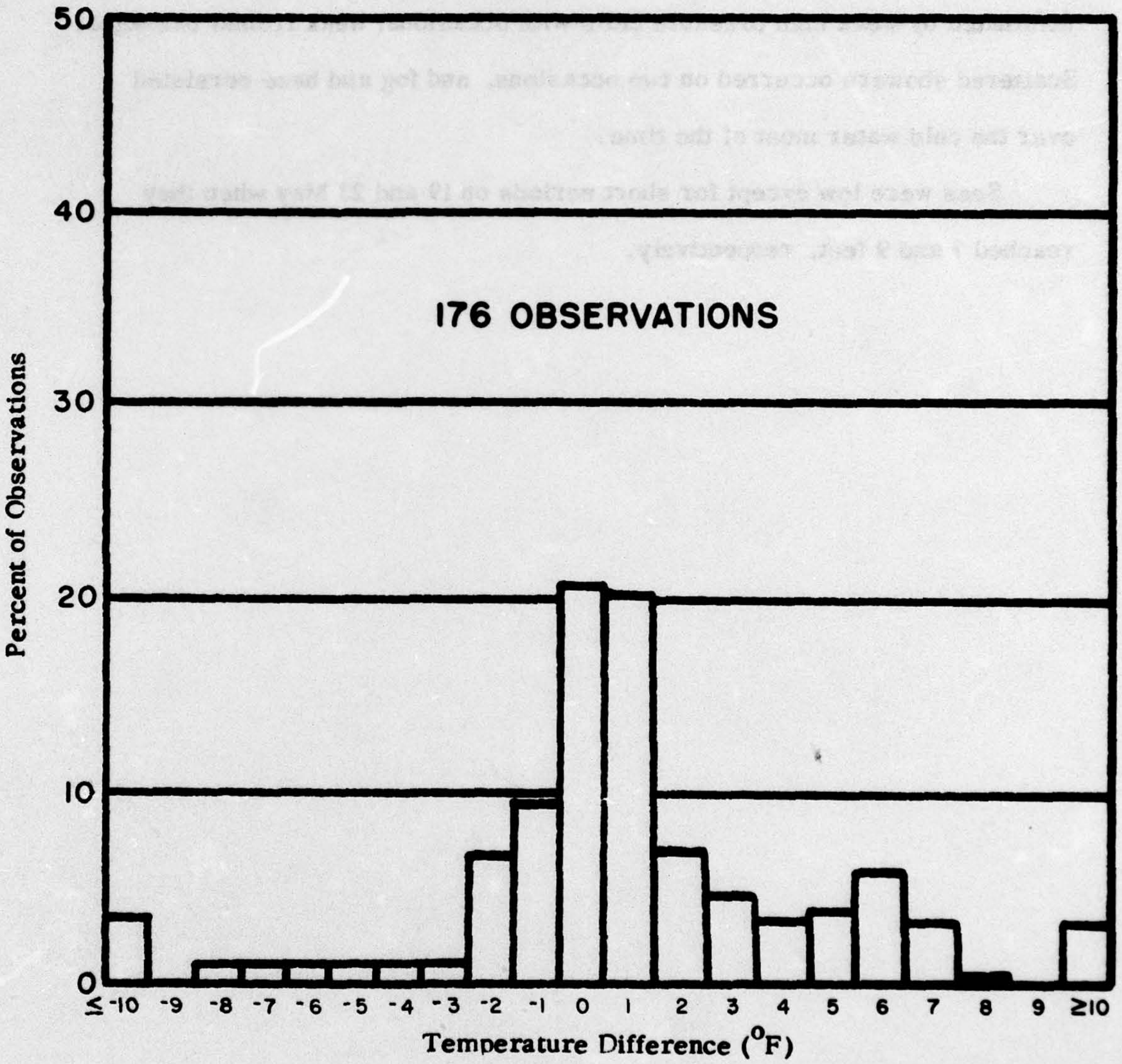


Figure 7 Frequency Distribution of Differences Between BT and Injection Temperatures (Layer Depth >20 Feet)

VI. METEOROLOGY

Weather conditions throughout exercise CANUS-SLAMEX-63 were dominated by weak high pressure cells with occasional weak frontal passages. Scattered showers occurred on two occasions, and fog and haze persisted over the cold water most of the time.

Seas were low except for short periods on 19 and 23 May when they reached 7 and 9 feet, respectively.